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(54) **SELF-LOCKING CONNECTOR COUPLING**

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(58) **Field of Classification Search**
CPC H01R 13/622
See application file for complete search history.

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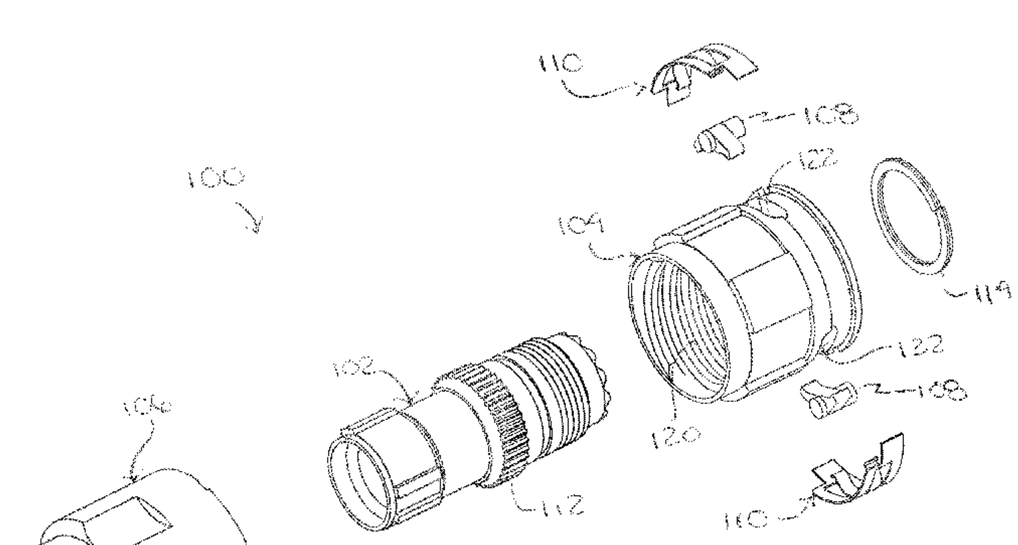
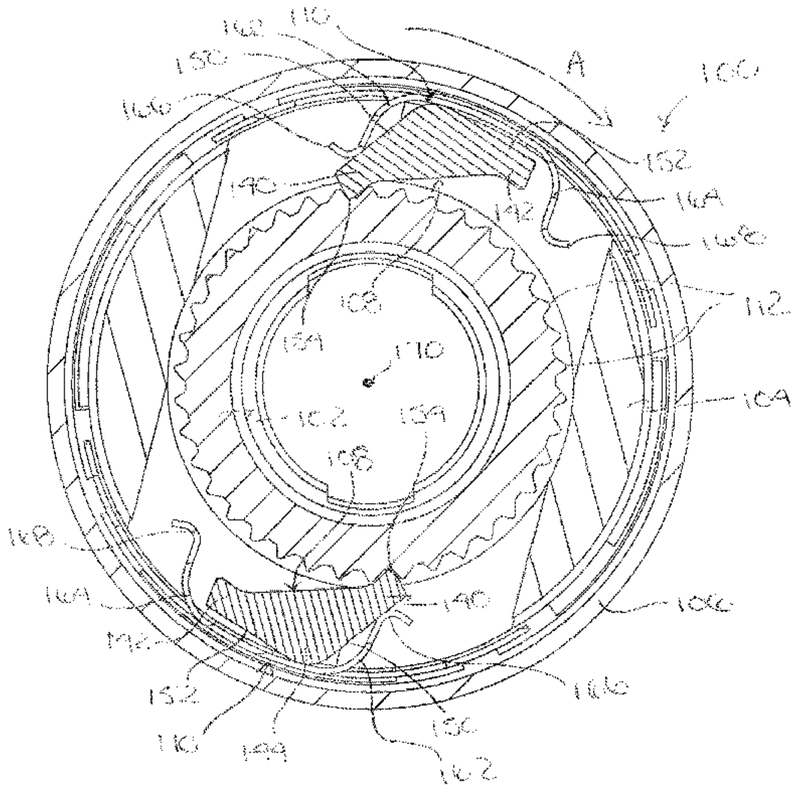
(57) **ABSTRACT**

A connector coupling that has a body, an inner sleeve receiving the body, at least one self-locking pawl pivotably coupled to the inner sleeve that is configured to toggle between first and second positions in engagement with ratchet teeth of the body, and an outer sleeve surrounding the inner sleeve. The inner and outer sleeves are rotatable together in opposite mating and unmating directions. At least one spring member is attached to the outer sleeve and is configured to bias the pawl. When the pawl is in the first position engaging the ratchet teeth, the inner and outer sleeves are rotatable together in the mating direction only and prevented from rotating in the unmating direction and when the pawl is in the second position engaging the ratchet teeth, the inner and outer sleeves are rotatable together in the unmating direction only and prevented from rotating in the mating direction.

21 Claims, 3 Drawing Sheets





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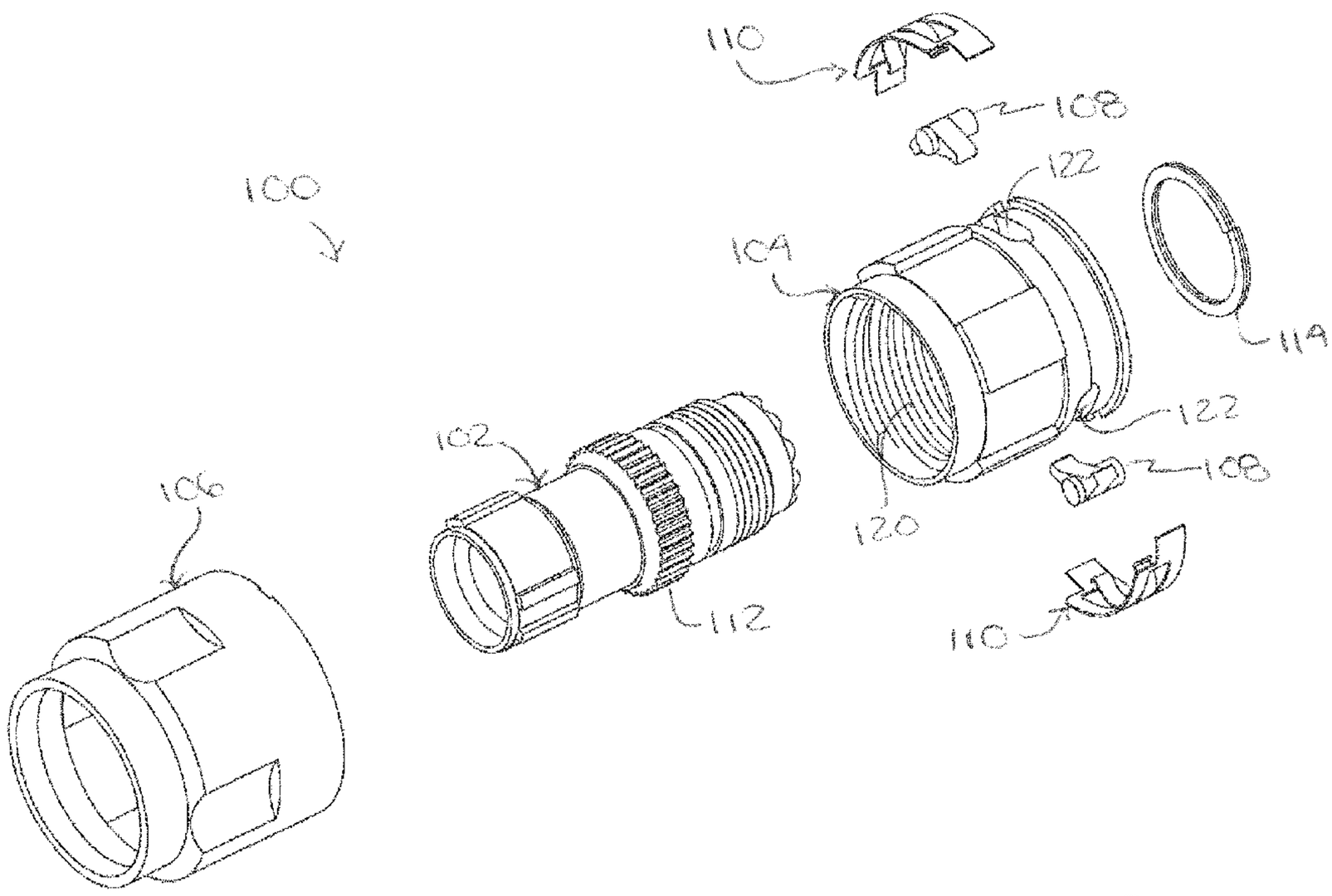

FIGURE 1

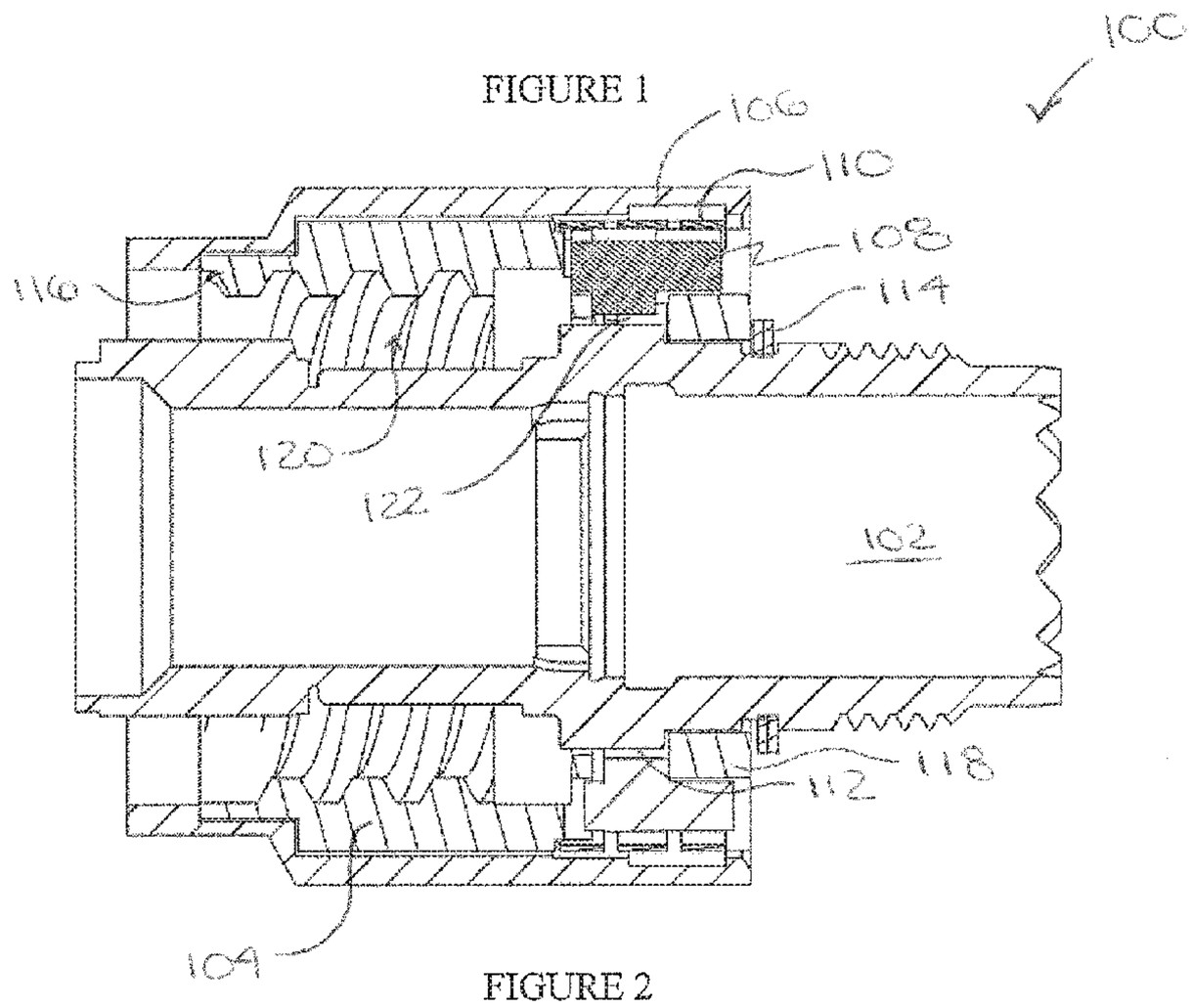

FIGURE 2

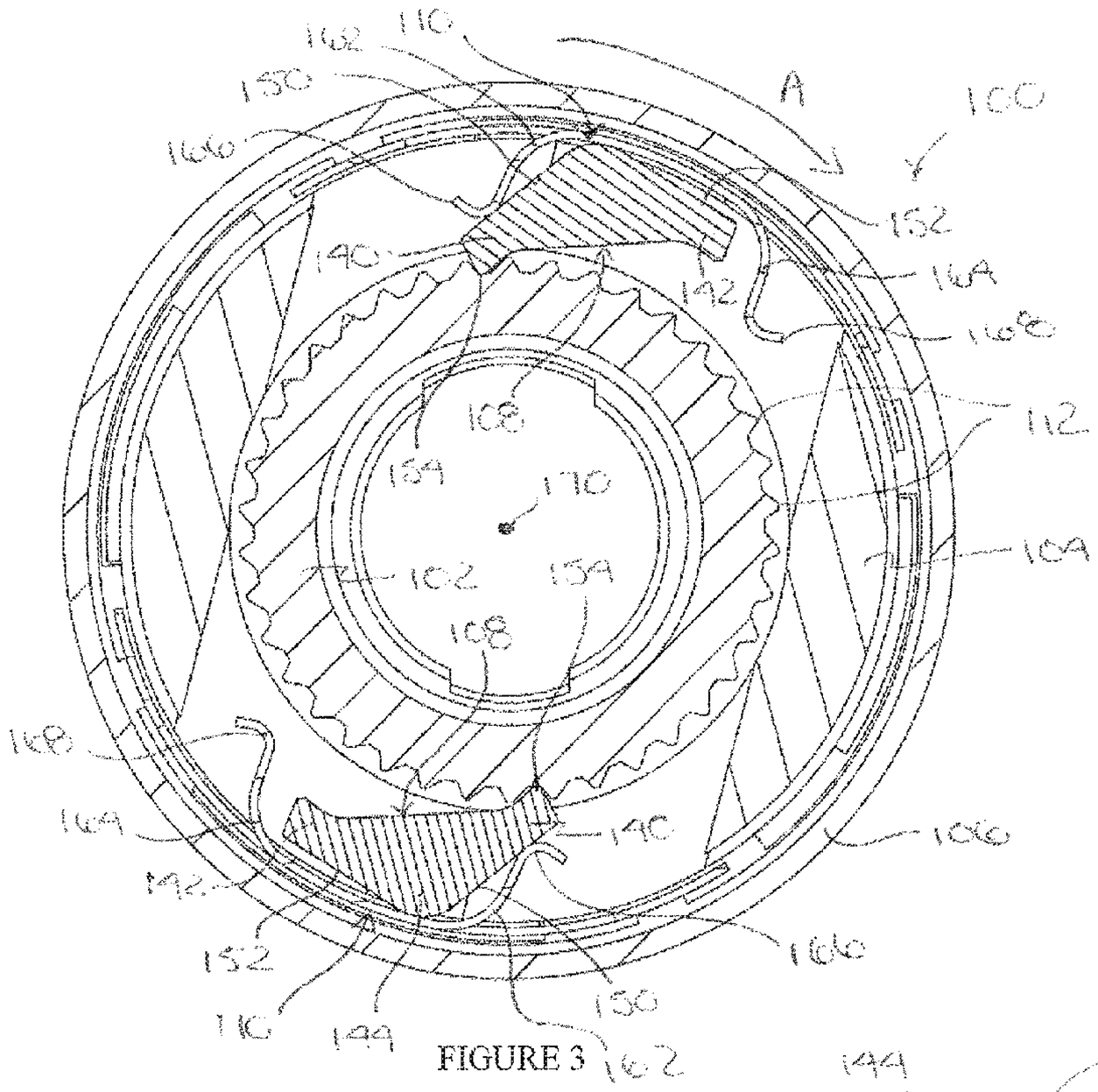

FIGURE 3

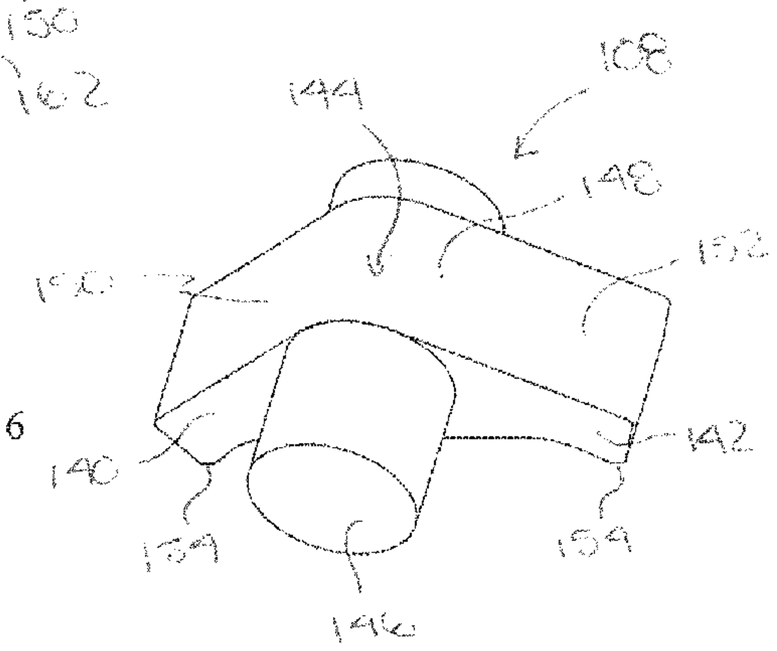

FIGURE 6

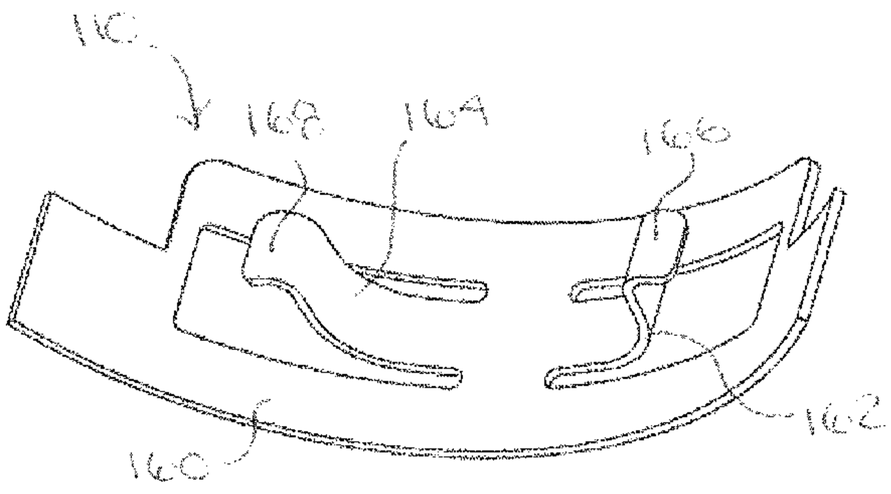

FIGURE 7

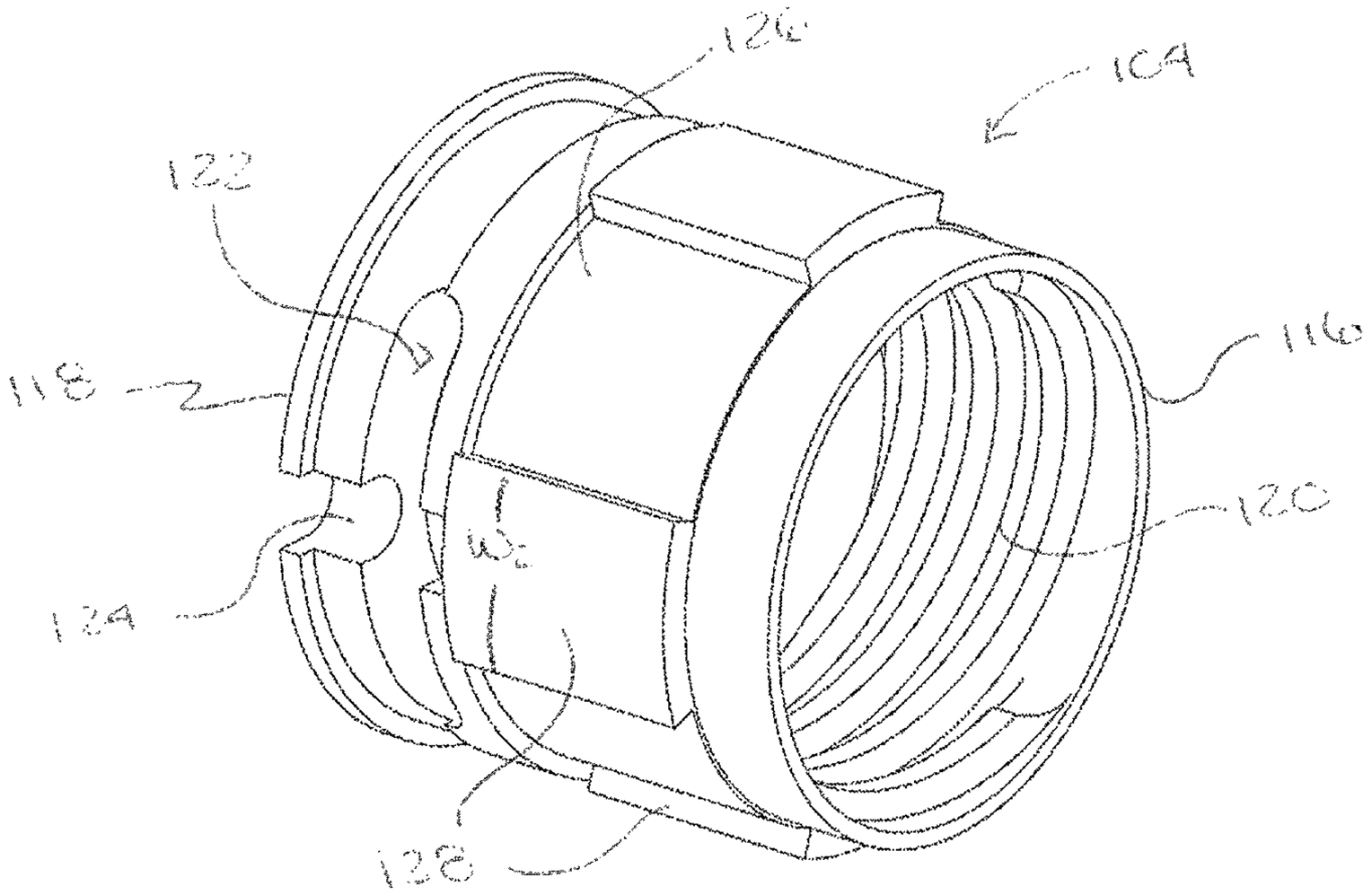

FIGURE 4

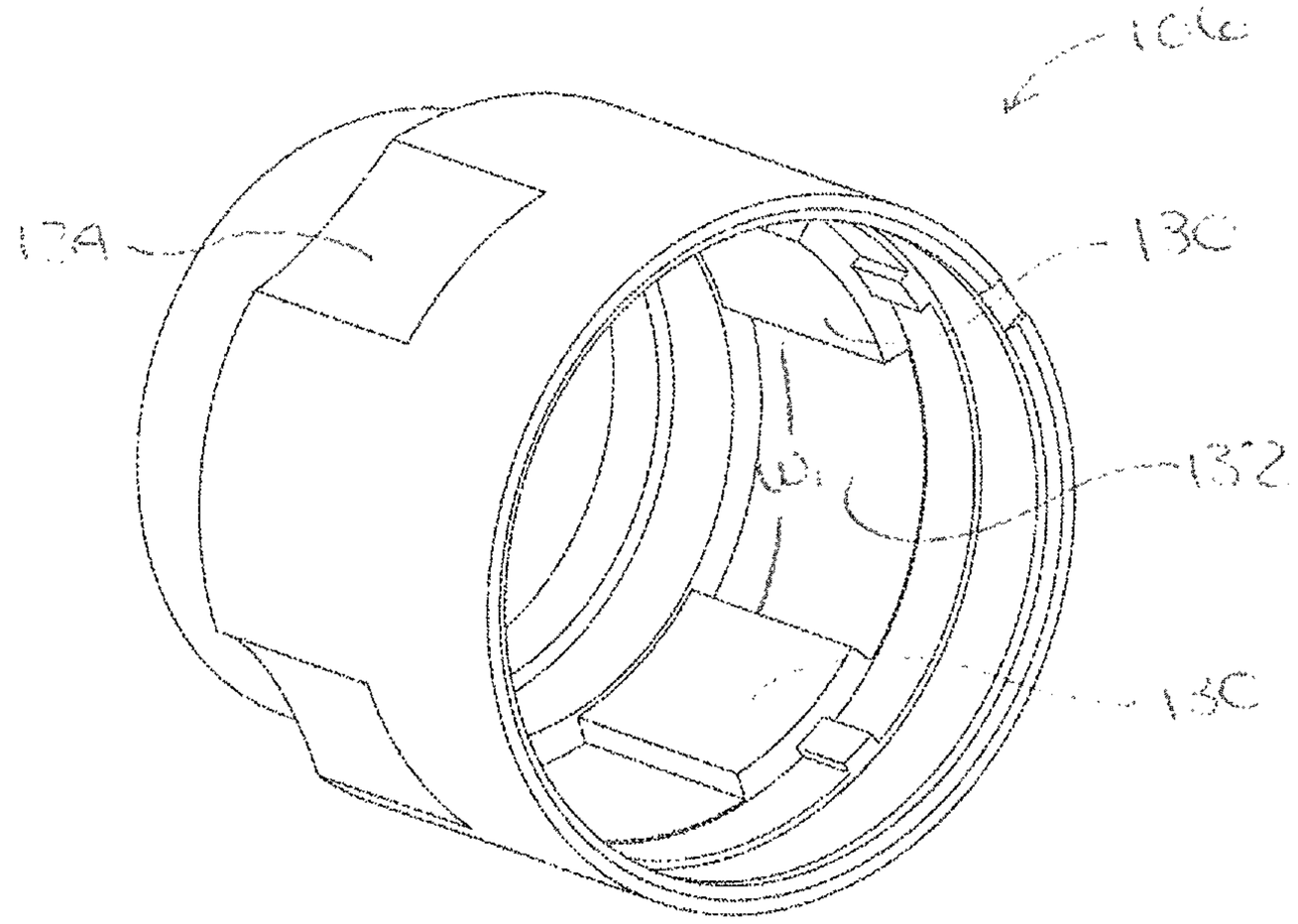

FIGURE 5

SELF-LOCKING CONNECTOR COUPLING

FIELD OF THE INVENTION

The present application relates to an anti-vibration coupling for an electrical connector that prevents loosening of the electrical connector due to conditions, such as vibration. More specifically, the anti-vibration coupling self-locks to prevent loosening of the coupling in either the mating or unmating positions.

BACKGROUND OF THE INVENTION

Electrical connector assemblies generally include mating plug and receptacle connectors. Often a threaded nut or collar is used to mate the plug and receptacle connectors. When an electrical connector assembly is subject to vibration or shock, however, the mating connectors of the assembly often become loose or even decouple. The loosening or decoupling usually occurs because the coupling nut counter rotates, that is it rotates in a direction opposite the mating or locking direction, thereby compromising the integrity of both the mechanical and electrical connection between the plug and receptacle connectors.

Examples of some prior art couplings for electrical connector assemblies include U.S. Pat. No. 8,579,644 to Cole et al.; U.S. Pat. No. 7,914,311 to Gallusser et al.; U.S. Pat. No. 7,905,741 to Wade et al., U.S. Pat. No. 6,293,595 to Marc et al.; U.S. Pat. No. 6,123,563; U.S. Pat. No. 6,086,400 to Fowler; U.S. Pat. No. 5,957,716 to Buckley et al.; U.S. Pat. No. 5,435,760 to Miklos; U.S. Pat. No. 5,399,096 to Quillet et al.; U.S. Pat. No. 4,208,082 to Davies et al.; U.S. Pat. No. 3,917,373 to Peterson; and U.S. Pat. No. 2,728,895 to Quackenbush, the subject matter of each of which is hereby incorporated by reference. Such prior art couplings, however, are costly to manufacture, require complex precision molded parts, and have multiple moving parts. Also, existing locking connector couplings often exceed the standard dimensional envelop of typical electrical connectors, particularly circular electrical connectors.

Therefore, a need exists for an anti-vibration coupling that self-locks to prevent loosening of the mated plug and receptacle and that has a reduced number of parts, is cheaply manufactured, and sized to reside within the typical dimensional envelop of electrical connectors, particularly circular connectors.

SUMMARY OF THE INVENTION

Accordingly, an exemplary embodiment of the present invention provides a connector coupling that includes a connector body that has ratchet teeth and defines a longitudinal axis, an inner sleeve receives the connector body, at least one self-locking pawl is pivotably coupled to the inner sleeve and is configured to toggle between first and second positions in engagement with the ratchet teeth of said connector body. An outer sleeve surrounds the inner sleeve and the inner and outer sleeves are rotatable together in opposite mating and unmating directions with respect to the longitudinal axis of the connector body. At least one spring member is attached to an inner surface of the outer sleeve that is configured to bias the at least one self-locking pawl. When the at least one self-locking pawl is in the first position engaging the ratchet teeth, the inner and outer sleeves are rotatable together in the mating direction only and prevented from rotating in the unmating direction and when the at least one self-locking pawl is in the second position engaging the ratchet teeth, the inner and outer sleeves are rotatable together in the unmating direction only and prevented from rotating in the mating direction.

The present invention may also provide a connector coupling that includes a connector body that has ratchet teeth and defines a longitudinal axis, an inner sleeve receives the connector body, and at least one self-locking pawl that has opposite first and second ends and an apex portion therebetween. The apex portion has a pivot pin coupled to the inner sleeve allowing the at least one self-locking pawl to toggle between a first position, in which the first end engages the ratchet teeth, and a second position, in which the second end engages the ratchet teeth. An outer sleeve surrounds the inner sleeve. The inner and outer sleeves are rotatable together in opposite mating and unmating directions with respect to the longitudinal axis of the connector body. At least one spring member is attached to an inner surface of the outer sleeve and has first and second spring arms configured to bias the at least one self-locking pawl. When the at least one self-locking pawl is in the first position, the first spring arm contacts the first end of the at least one self-locking pawl to bias the at least one self-locking pawl in the first position and the inner and outer sleeves are rotatable together in the mating direction only and prevented from rotating in the unmating direction. When the at least one self-locking pawl is in the second position, the second spring arm contacts the second end of the at least one self-locking pawl to bias the at least one self-locking pawl in the second position and the inner and outer sleeves are rotatable together in the unmating direction only and prevented from rotating in the mating direction.

The present invention may yet further provide a method of coupling a connector coupling to a mating connector, the connector coupling having a connector body received in an inner sleeve and an outer sleeve surrounding the inner sleeve, comprising the steps of rotating the outer and inner sleeves together in a mating direction with respect to a longitudinal axis of the connector body and engaging at least one self-locking pawl coupled to the inner sleeve with ratchet teeth of the connector body in a first position preventing rotation of the inner and outer sleeves in an unmating direction opposite the mating direction; engaging threads of the inner sleeve with a mating connector; releasing the at least one self-locking pawl from engagement with the ratchet teeth in the first position by rotating the outer sleeve with respect to the inner sleeve for a controlled distance; and rotating the outer and inner sleeves together in the unmating direction and engaging the at least one self-locking pawl with the ratchet teeth in a second position preventing rotation of the inner and outer sleeves in the mating direction.

Other objects, advantages and salient features of the invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is an exploded view of a connector coupling in accordance with an exemplary embodiment of the present invention;

FIG. **2** is a cross-sectional view of the connector coupling illustrated in FIG. **1**, taken along the longitudinal axis of the connector coupling;

FIG. **3** is a cross-sectional view of the connector coupling illustrated in FIG. **1** taken along the transverse axis of the connector coupling;

FIG. **4** is a perspective view of an inner sleeve of the connector coupling illustrated in FIG. **1**;

FIG. **5** is a perspective view of an outer sleeve of the connector coupling illustrated in FIG. **1**;

FIG. **6** is a perspective view of a pawl of the connector coupling illustrated in FIG. **1**; and

FIG. **7** is a perspective view of a spring member of the connector coupling illustrated in FIG. **1**.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Referring to FIGS. **1-7**, the present invention relates to a connector coupling **100** for electrical connectors, such as circular electrical connectors. The coupling **100** is designed to self-lock in both mating and unmating directions to prevent loosening of the coupling when mated with another connector and to prevent separation of (and potential loss of) components of the coupling, particularly when subject to extraordinary conditions, such as vibration. The coupling **100** generally includes a connector body **102**, an inner sleeve **104** that receives the connector body **102**, an outer sleeve **106** that surrounds inner sleeve **104**, one or more toggling pawls **108** providing self-locking to the coupling **100**, and one or more spring members **110** corresponding to and biasing the one or more pawls **108**.

Connector body **102** interfaces with a mating connector (not shown) and includes a plurality of ratchet teeth **112** for engaging the one or more pawls **108**. The ratchet teeth **112** preferably form a continuous annular ring around the body **102**, as best seen in FIG. **1**. Inner sleeve **104** receives connector body **102**, as seen in FIG. **2**, which is retained therein by retaining ring **114**. Inner sleeve **104** may include a front interface end **116**, an opposite rear end **118**, and internal threads **120** therebetween for engaging the mating connector. Proximal the rear end **118** of inner sleeve **104** are one or more cavities **122** each sized to receive one of the pawls **108** such that the pawl therein may toggle freely. Connected to each cavity **122** is a cutout **124** formed in the inner sleeve's rear end **118** for accommodating a portion of the pawl received in the cavity.

An outer surface **126** of inner sleeve **104** preferably engages with outer sleeve **106**. In particular, outer surface **126** may include one or more alignment members **128** that engage corresponding alignment members **130** of outer sleeve **106**. As seen in FIGS. **4** and **5**, the one or more alignment members **128** of inner sleeve **104** may be, for example, a key or keys extending from outer surface **126**, and the one or more alignment members **130** of outer sleeve **106** may be, for example, a keyway or keyways in an inner surface **132** thereof that receives the key **128**, thereby interlocking the sleeves **104** and **106**. Alternatively, the keys **128** may be provided on the outer sleeve **106** and the keyways **130** on the inner sleeve **104**. In a preferred embodiment, each key **128** and each keyway **130** is sized to provide a controlled distance of rotation between the inner and outer sleeves **104** and **106**. For example, each keyway **130** may have a width W_1 that is larger than the width W_2 of each key **128**, such that each key **128** is movable a certain distance circumferentially from one side of the respective keyway **130** to the other. That circumferential distance moveable by the key **128** in the keyway **130** (or the difference between W_1 and W_2) defines the controlled distance of rotation between the inner and outer sleeves **104** and **106**. Outer sleeve **106** may include an outer gripping surface **134** to facilitate gripping and rotation of outer sleeve **106**.

Each of the one or more self-locking pawls **108** is received in a respective cavity **122** of inner sleeve **104** and is adapted to engage the ratchet teeth **112** of connector body **102**, as seen in FIG. **3**. Each pawl **108** includes opposite first and second ends **140** and **142** and an apex portion **144**, therebetween, as seen in FIG. **6**. A pivot pin **146** extends through apex portion **144** that allows the pawl **108** to toggle between a first position (e.g. when first end **140** engages ratchet teeth **112**) and a second position (e.g. when second end **142** engages ratchet teeth **112**). The pivot pin **146** sits in cutout **124** of the respective cavity **122**. Each pawl **108** may have first and second working surface portions **150** and **152** on an outer surface **148** thereof for engaging one of the spring members **110** in the first and second positions, respectively. Each of the first and second ends **140** and **142** of the pawl **108** preferably includes a lip **154** shaped to positively engage the ratchet teeth **112**.

Each of the one or more spring members **110** is attached to the inner surface **132** of outer sleeve **106**, as seen in FIG. **3**, and positioned to bias each pawl **108** into engagement with the ratchet teeth **112**. Each spring member **110** preferably includes a fixed base **160** that may be curved to match that of the outer sleeve's inner surface **132**. First and second springs arms **162** and **164** extend from the fixed base **160**. A tail end **166** of the first spring arm **162** engages first working surface portion **150** of pawl **108** when pawl **108** is in the first position (FIG. **3**) and a tail end **168** of the second spring arm **164** engages second working surface portion **152** when pawl **108** is in the second position. The tail ends **166** and **168** may have a generally L-shape.

When mating connector coupling **100** to a mating connector, inner and outer sleeves **104** and **106** are rotated together in a mating direction with respect to a longitudinal axis **170** of the connector body **102** (arrow A in FIG. **3**) such that the one or more pawls **108** engage the ratchet teeth **112** in a first position wherein each pawl **108** may ratchet over the teeth **112** in the mating direction while preventing rotation of the inner and outer sleeves in an unmating direction opposite the mating direction. When in the first position, first arm **162** of each spring member **160** pushes on first working surface portion **150** of each pawl **108**, thereby biasing the first end **140** of each pawl **108** into engagement with ratchet teeth **112** while also allowing the first end **140** of each pawl **108** to ratchet over the teeth **112** when the coupling **100** is rotated in the mating direction. If inner and outer sleeves **104** and **106** are rotated in the unmating direction with respect to the connector body **102**, such as due to vibration, the second working surface portion **152** of each pawl **108** will abut the fixed base **160** of the spring member **110** and/or the inner surface **132** of the outer sleeve **106** such that the first end **140** of each pawl **108** cannot disengage from ratchet teeth **112**, thereby self-locking the coupling **100**. Thus, once inner and outer sleeves **104** and **106** are rotated together in the mating direction and the internal threads **120** of the connector body **102** engage the mating connector, the coupling **100** is prevented from loosening in the unmating direction by the self-locking pawls **108**.

To release the coupling **100** from engagement with a mating connector, outer sleeve **106** is rotated with respect to inner sleeve **104** for the controlled distance, thereby moving each spring member **110** fixed to outer sleeve **106** the controlled distance to toggle each pawl **108** from the first

position to the second position. The first ends **140** of pawls **108** are released from engagement with teeth **112** and moved to the second position in which the second ends **142** of each pawl **108** engage with ratchet teeth **112**. The second spring arm **164** pushes on second working surface portion **152** of each pawl **108** to bias each pawl into engagement with teeth **112** in the second position. That allows inner and outer sleeves **104** and **106** to rotate together in the unmating direction to release the internal threads **120** of connector body **102** from the mating connector. Like in the first position, each pawl **108** is allowed to ratchet over ratchet teeth **112** as the sleeves **104** and **106** are rotated in the unmated direction.

Once in the second position, the one or more pawls **108** self-lock to prevent rotation of sleeves **104** and **106** in the mating direction (opposite the unmating direction). If the outer sleeve **106** is rotated in the mating direction when the pawls **108** are in the second position, first working surface portions **150** of each pawl **108** will abut the fixed base **160** of the spring member **110** and/or the inner surface **132** of the outer sleeve **106** such that the second end **142** of each pawl **108** cannot disengage from ratchet teeth **112**. This prevents separation of the coupling's components, particularly outer sleeve **108**, which could otherwise be separated (such as by being rotated off the coupling) and lost from the coupling **100**.

While particular embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A connector coupling, comprising:

a connector body, said connector body having ratchet teeth and defining a longitudinal axis;

an inner sleeve receiving said connector body;

at least one self-locking pawl pivotably coupled to said inner sleeve, said at least one self-locking pawl being configured to toggle between first and second positions in engagement with said ratchet teeth of said connector body;

an outer sleeve surrounding said inner sleeve, said inner and outer sleeves being rotatable together in opposite mating and unmating directions with respect to said longitudinal axis of said connector body; and

at least one spring member attached to an inner surface of said outer sleeve, said at least one spring member being configured to bias said at least one self-locking pawl,

wherein when said at least one self-locking pawl is in said first position engaging said ratchet teeth, said inner and outer sleeves are rotatable together in said mating direction only and prevented from rotating in said unmating direction and when said at least one self-locking pawl is in said second position engaging said ratchet teeth, said inner and outer sleeves are rotatable together in said unmating direction only and prevented from rotating in said mating direction.

2. The connector coupling of claim **1**, wherein

said outer sleeve is rotatable with respect to said inner sleeve for a controlled distance to release said at least one self-locking pawl from engagement with said ratchet teeth.

3. The connector coupling of claim **2**, wherein

said inner and outer sleeves include corresponding alignment members.

4. The connector coupling of claim **3**, wherein

said alignment member of one of said inner and outer sleeves is at least one key and said alignment member of the other of said inner and outer sleeves is at least one keyway that receives said at least one key, and the controlled distance is defined by a circumferential distance moveable by said key in said keyway.

5. The connector coupling of claim **1**, wherein

said at least one self-locking pawl has opposite first and second ends and an apex portion therebetween, and a pivot pin extends through said apex portion allowing said at least one self-locking pawl to toggle between said first and second positions.

6. The connector coupling of claim **5**, wherein

each of said first and second ends has a lip for engaging said ratchet teeth in said first and second positions, respectively.

7. The connector coupling of claim **5**, wherein

said at least one self-locking pawl includes first and second working surface portions on an outer surface thereof for engaging said at least one spring member.

8. The connector coupling of claim **1**, wherein

said at least one spring member includes a fixed base attached to said inner surface of said outer sleeve, and first and second springs extending from said fixed base, said first spring arm includes tail end shaped to contact a first end of said at least one self-locking pawl when said at least one self-locking pawl is in said first position, and said second spring arm includes a tail end shaped to contact a second end opposite said first end of said at least one self-locking pawl when said at least one self-locking pawl is in said second position.

9. The connector coupling of claim **1**, wherein

said inner sleeve including at least one cavity that receives said at least one self-locking pawl, said cavity is sized to allow free toggle movement of said at least one self-locking pawl between said first and second positions.

10. The connector coupling of claim **9**, wherein

an outer surface of said inner sleeve includes at least one cutout adjacent said cavity, said cutout is adapted to receive a pivot pin of said at least one self-locking pawl.

11. The connector coupling of claim **1**, wherein

an inner surface of said inner sleeve includes threads for engaging a mating connector.

12. The connector coupling of claim **1**, wherein

said ratchet teeth form a continuous annular ring around said connector body.

13. A connector coupling, comprising:

a connector body, said connector body having ratchet teeth and defining a longitudinal axis;

an inner sleeve receiving said connector body;

at least one self-locking pawl having opposite first and second ends and an apex portion therebetween, said apex portion having a pivot pin coupled to said inner sleeve allowing said at least one self-locking pawl to toggle between a first position, in which said first end engages said ratchet teeth, and a second position, in which said second end engages said ratchet teeth;

an outer sleeve surrounding said inner sleeve, said inner and outer sleeves being rotatable together in opposite mating and unmating directions with respect to said longitudinal axis of said connector body; and

at least one spring member attached to an inner surface of said outer sleeve, said at least one spring member having first and second spring arms configured to bias said at least one self-locking pawl,

wherein when said at least one self-locking pawl is in said first position, said first spring arm contacts said first end of said at least one self-locking pawl to bias said at least one self-locking pawl in said first position and said inner and outer sleeves are rotatable together in said mating direction only and prevented from rotating in said unmating direction, and

wherein when said at least one self-locking pawl is in said second position, said second spring arm contacts said second end of said at least one self-locking pawl to bias said at least one self-locking pawl in said second position and said inner and outer sleeves are rotatable together in said unmating direction only and prevented from rotating in said mating direction.

14. The connector coupling of claim **13**, wherein

said outer sleeve is rotatable with respect to said inner sleeve for a controlled distance to release said at least one self-locking pawl from engagement with said ratchet teeth.

15. The connector coupling of claim **14**, wherein

one of said inner and outer sleeves has at least one key and the other of said inner and outer sleeves has at least one keyway that receives said at least one key, and the controlled distance is defined by a radial distance moveable by said key in said keyway.

16. The connector coupling of claim **13**, wherein

each of said first and second ends of said at least one self-locking pawl has a lip for engaging said ratchet teeth in said first and second positions, respectively.

17. The connector coupling of claim **13**, wherein

said at least one self-locking pawl includes first and second working surface portions on an outer surface thereof for engaging said first and second spring arms, respectively.

18. The connector coupling of claim **13**, wherein

said inner sleeve including a cavity that receives said at least one self-locking pawl, said cavity is sized to allow free toggle movement of said at least one self-locking pawl between said first and second positions; and

an outer surface of said inner sleeve includes a cutout adjacent said cavity, said cutout is adapted to receive said pivot pin of said at least one self-locking pawl.

19. A method of coupling a connector coupling to a mating connector, the connector coupling having a connector body received in an inner sleeve and an outer sleeve surrounding the inner sleeve, comprising the steps of:

rotating the outer and inner sleeves together in a mating direction with respect to a longitudinal axis of the connector body and engaging at least one self-locking pawl coupled to the inner sleeve with ratchet teeth of the connector body in a first position preventing rotation of the inner and outer sleeves in an unmating direction opposite the mating direction;

engaging threads of the inner sleeve with a mating connector;

releasing the at least one self-locking pawl from engagement with the ratchet teeth in the first position by rotating the outer sleeve with respect to the inner sleeve for a controlled distance; and

rotating the outer and inner sleeves together in the unmating direction and engaging the at least one self-locking pawl with the ratchet teeth in a second position preventing rotation of the inner and outer sleeves in the mating direction.

20. The method of claim **19**, further comprising the steps of

biasing the at least one self-locking pawl in the first position; and

biasing the at least one self-locking pawl in the second position.

21. The method of claim **19**, wherein

one of the inner and outer sleeves has at least one key and the other of the inner and outer sleeves has at least one keyway that receives the at least one key, and the controlled distance is defined by a circumferential distance moveable by the key in the keyway.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

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APPLICATION NO. : 15/178868
DATED : May 30, 2017
INVENTOR(S) : Erik Strahl

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Column 1:
(72) Inventors should read: **Erik Strahl, Unadilla, NY (US)**

Signed and Sealed this
Tenth Day of October, 2017

Joseph Matal

Joseph Matal
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office